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Title: Northstar Mo99 Window Tests

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Northstar Mo99 Window Tests

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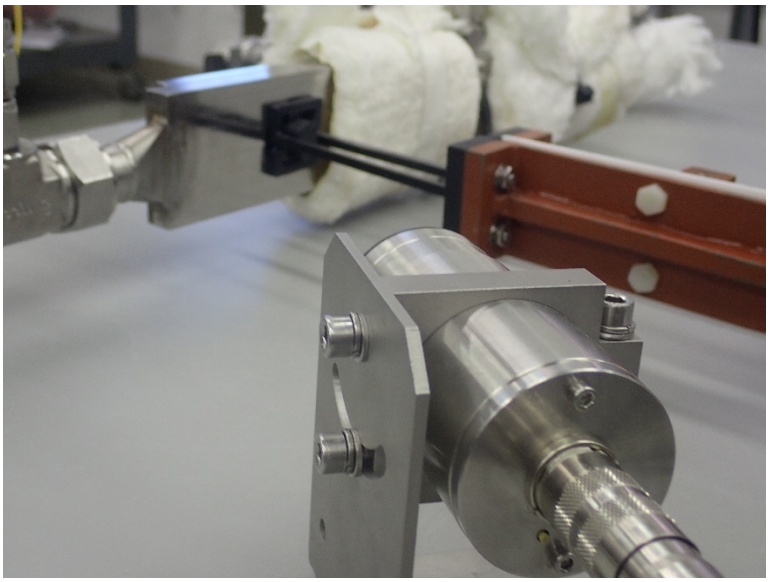
Summary Report

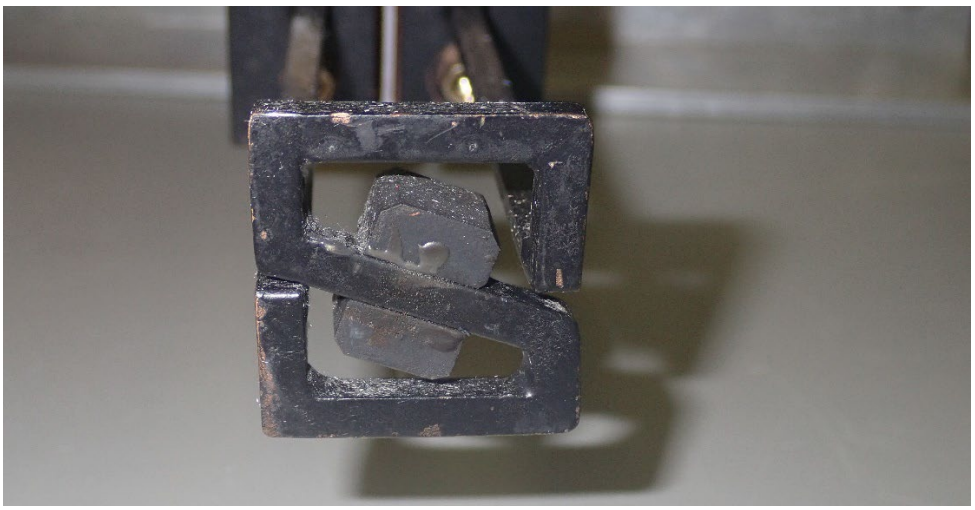
Tests were completed for window to “first disk” (actually a steel plate for these expariments) gaps of 20 mil as per design gap as well as 10 mil and 30 mil gaps to span the range of possible variations. With possible disk distortion in beam, another test with 0 gap was performed. Based on deflections measured during the pressure test, the 0 gap was most likely very near 3 mil.

In pictures, the setup is:

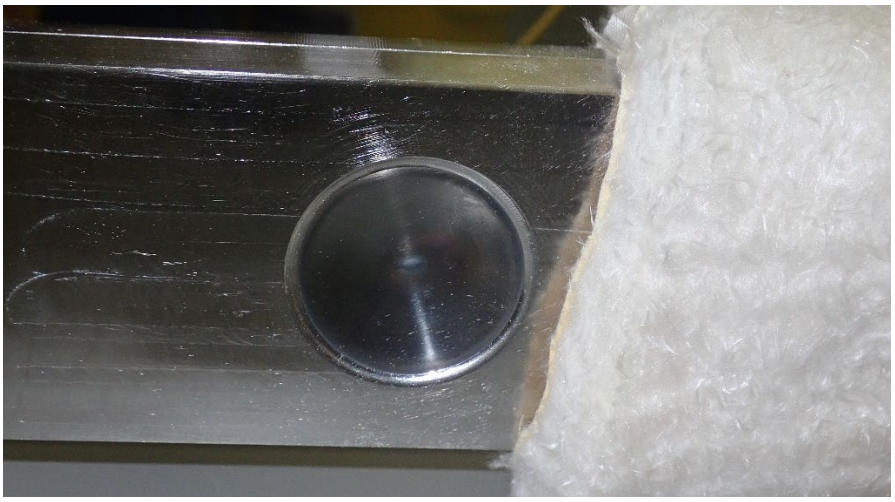
View looking straight on. Red bus delivers power to the “coil” (black) to the window, not visible, welded into the inconel channel. Helium comes in from the left, P and T measured there. Insulation on the right improves accuracy and time response of the DT measurement for power calculation.



View from the pyrometer. Coil so much obscures the view of the window that the pyrometer reading is indicative only. Same with IR camera, no longer used here.



The Z coil, with fluxtrol at center to direct power in the preferred direction. The shape does a good job of replicating a circular spot with power highest in the center.



The window. The perfect weldment the work of Applied Fusion.

Because the coil so well blocks the view of the window, no temperature measurement was possible unless the window reached visible state. This is approximately 600 C in the lab because we cannot achieve totally dark conditions.

Results

By analysis, the power in the window is 1610 W, based on 42 MeV and 5.71 mA on target, the current split between 2 sides. Flow rate for the 10, 20 and 30 mil gaps was based on a ¼ symmetry model, which means that the same gap is assumed on both sides. For the 3 mil gap, the analysis was done with a 20 mil gap on the opposite side. Pressure varied slightly from one test to another, but is nominally 275 psig.

In the tests the flow rate and pressure are set, then the power is ramped up until the intended power level is reached or exceeded. Power is determined strictly by calorimetry of the helium, with measured mass flow rate and temperature rise, with a specific heat of 5.2 J/g-K. The results are summarized in the following tble.

Gap width (mil)	Mass Flow Rate (g/s)	Power (W)
3	13.2	1737
3	10	1819
10	22.2	1639
20	32.4	2021
30	37.5	1685

There was no visible color, red glow, from the window except the 3 mil gap test at 13.2 g/s. When the mass flow reduced to 10 g/s the test showed no heat into the visible range. It is evident that the separation and vorticity at the expanding portion of the flow downstream of the center is causing some

back pressure that is reducing the flow locally at the critical center of the window. In that case, a lower mass flow rate reduces the window temperature by allowing more flow where it is needed most.

Conclusion

The window cooling is more than adequate for all of the test conditions proposed to date. Further testing us being considered.